

At Greenwich on July 28

Sun rises, 4h. 20m.; souths, 12h. 6m. 14'0s.; daily decrease of southing, 1'3s.; sets, 19h. 53m.: right asc. on meridian, 8h. 31'6m.; decl. 18° 54' N. Sidereal Time at Sunset, 16h. 20m.

Moon (New on July 28, oh.) rises, 4h. 27m.; souths, 12h. 33m.; sets, 20h. 28m.: right asc. on meridian, 8h. 58'4m.; decl. 19° 51' N.

Planet.	Rises.		Souths.		Sets.		Right asc. and declination on meridian.				
	h.	m.	h.	m.	h.	m.	h.	m.	°	'	
Mercury...	3	13	...	11 19	...	19 25	...	7	44.6	...	22 4 N.
Venus...	1	1	...	8 56	...	16 51	...	5	20.5	...	20 20 N.
Mars...	3	10	...	11 18	...	19 26	...	7	43.1	...	22 20 N.
Jupiter...	17	38	...	21 31	...	1 24*	...	17	58.1	...	23 22 S.
Saturn...	5	46	...	13 11	...	20 36	...	9	36.7	...	15 27 N.
Uranus...	11	12	...	16 42	...	22 12	...	13	8.6	...	6 38 S.
Neptune..	23	56*	...	7 45	...	15 34	...	4	9.8	...	19 23 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

July.	h.	
28 ...	5	Mercury in conjunction with and 0° 14' south of Mars.
28 ...	20	Mercury at least distance from the Sun.
29 ...	7	Saturn in conjunction with and 2° 16' south of the Moon.

Variable Stars.

Star.	R.A.		Decl.			h. m.
	h. m.	h. m.				
Algol ...	3	1'0	40 32 N.	...	Aug. 2,	1 50 m
R Ursæ Majoris ...	10	36'8	69 22 N.	...	...	3, M
W Virginis ...	13	20'3	2 48 S.	...	July 31,	22 0 m
X Boötis ...	14	19'0	16 50 N.	...	Aug. 2,	M
R Camelopardalis.	14	26'0	84 20 N.	...	July 31,	M
δ Libræ ...	14	55'1	8 5 S.	...	Aug. 1,	2 32 m
U Coronæ ...	15	13'7	32 3 N.	...	...	3, 0 20 m
U Ophiuchi...	17	10'9	1 20 N.	...	July 28,	23 17 m
				...	Aug. 3,	0 2 m
X Sagittarii...	17	40'6	27 47 S.	...	July 28,	23 0 M
				...	Aug. 2,	3 0 m
U Sagittarii...	18	25'6	19 12 S.	...	July 29,	0 0 M
U Aquilæ ...	19	23'4	7 16 S.	...	...	31, 22 0 m
η Aquilæ ...	19	46'8	0 43 N.	...	Aug. 3,	3 0 M
T Vulpeculæ ...	20	46'8	27 50 N.	...	July 31,	22 0 M
δ Cephei ...	22	25'1	57 51 N.	...	...	30, 0 0 M

M signifies maximum; m minimum.

Meteor-Showers.

R.A. Decl.

Near δ Andromedæ ...	8	...	32 N.	...	Swift; streaks.
δ Cassiopeiæ ...	20	...	55 N.	...	...
The Perseids ...	33	...	55 N.	...	...
The Aquarids ...	340	...	13 S.	...	Max. July 28.

GEOGRAPHICAL NOTES.

AN expedition is about to start for the exploration of Central Australia. Baron von Müller is interesting himself in the expedition, which will be under the command of the experienced explorer, Mr. Tietkens, who will also look specially after the botany and mineralogy. The point of departure will be Alice Springs, on the central telegraph line, and the country round Lake Amadeus will be carefully examined.

It is reported from Brisbane, according to the *Colonies and India*, that the Queensland Government has concluded an agreement with Mr. A. Weston to lead an exploring party into the almost untrodden recesses of the northern portion of the colony, with a view to bringing to light scientific treasures supposed to be hidden there. Mr. Weston has accepted the undivided responsibility of leadership. Messrs. Broadbent and Bailey will be associated with him, and will respectively discharge the duties of collecting fauna and flora. The party will explore the region lying to the north-west of Cairns, including the Bellenden Ker Range and the shores of the volcanic lakes. It is also thought that something may be heard of Leichardt's expedition, traces of which are popularly supposed to be yet found in the back country. Mr. Weston has refused to accept any pecuniary assistance from the Government for his services.

M. A. DELCOMMUNE, who has been exploring several of the affluents of the Upper Congo, has arrived in Brussels. He has

brought with him a valuable collection of African products, and some 200 views on the Upper Congo.

THE news that Dr. Macgregor, the Administrator of British New Guinea, has reached the summit of the Owen Stanley Range is of much interest. Since Captain Owen Stanley discovered the range, about forty-five years ago, various explorers have attempted to scale it, but all have failed. The summit reached by Dr. Macgregor is over 13,000 feet, and he reports several peaks almost equal in height. As Dr. Macgregor is a good botanist, his journey is likely to yield valuable scientific results.

DR. ALFRED HETTNER, in a communication to the *Verhandlungen* of the Berlin Geographical Society (No. 6, 1889), on his travels in Peru and Bolivia, gives the results of his observations on Lake Titicaca, which are of some interest. The surface of the lake, he states, has in the course of time been subject to great changes of level. The proof of these changes is to be found in the terraces around the lake. In a comparatively recent geological period, Dr. Hettner believes, the level of the lake must have been 20 metres higher than it is to-day, and the lake must have spread over the great part of the plain which now incloses it, perhaps as far as Lake Poopo. At a still earlier period the level of the lake must have been 200 metres above its present level, but between these stages, as many appearances indicate, the lake must have sunk below that level. The highest position of the lake-level is older than the glaciation of the district, and contemporaneous with a period of strong volcanic activity. The 20-metre high terraces may belong to the ice-period. For the idea of a former submersion below the sea Dr. Hettner can find no support; at the same time, he cannot altogether deny the possibility that at the time of the 200-metre terrace the lake may have had some connection with the ocean.

NITRATE OF SODA, AND THE NITRATE COUNTRY.¹

II.

WE will now consider the structure of the actual nitrate beds. As before mentioned, there is no nitrate under the flat Pampa; but exactly where the first slopes of the coast range spring out of the plain, there nitrate is found at a small but variable distance below the surface. The width of the belt varies with the slope of the hill, being greatest where the slope is least, and the vertical height of the highest part of the bed appears to vary from 100 to 120 feet above the plain. It is, however, most important to notice that *the beds of nitrate follow the slope of the Pampa, and not a level line*. For instance, the northern extremity of the Pampa is some hundreds of feet higher than the southern portion, but the nitrate beds follow the spring of the hill from the plain, throughout their whole extent.

A very different sequence of beds lies under the slope of the hills from those alternating layers of mud, sand, and gravel which are found under the level Pampa. The surface covering of loose dust and small stones, extending to a depth of only a few inches, is locally known as *chuca* (see Fig. 3). This seems to be a native word, but I have been unable to ascertain its meaning. Below the *chuca* comes a very hard layer of earth and stones, almost compacted into rock, from 1 to 2 feet thick, which is called *costra* (Span. crust). Under this lies the *caliche*, or true nitrate deposit. This is a bed of from 1 to 3 feet thick, usually of a whitish crystalline structure, containing from 20 to 50 per cent. of nitrate of soda, with a residuum made up chiefly of common salt and earthy matter. *Caliche* is an Indian word, and may possibly come from the Aymara word *callachi*, a shell, or skull.

Passing through the *caliche*, a hard layer of stones and earth, compacted with salt crystals, is usually encountered. The Spanish workmen call this "*congelado*," because it is congealed or concreted by the salt.

After a foot or so of this, there comes finally a bed of soft, loose, *sweet* earth, containing a few very small loose stones, known as *cova*. I could not discover the signification of this word; but the whole method of working a nitrate bed turns round the properties of the *cova*.

A workman, with three or four chisel-pointed bars of iron, hence called a *barretero*, stands on the surface of the ground, and chips out a round hole, about a foot in diameter, down to the level of the *cova*. This hole is called a *tiro*, or charge for

¹ Continued from p. 188.

gunpowder (see Fig. 3). A small boy then scrambles down the hole, and easily excavates the soft *cova* a little under the *congeló*, forming an opening called the *taza*, or cup. The *taza* only is then filled with a slow-burning gunpowder, made of nitrate of soda on the premises, a tamping put into the *tiro*, and the charge exploded. The valuable *caliche* bed is thus simply lifted and partially broken, without being blown into dust; and a party of men separate the nitrate from the worthless beds, and carry it to the factory, or *maquina*.

Caliche varies so much in composition that it is almost impossible to give a typical analysis. One very rich specimen gave:—

	Per cent.
Nitrate of soda...	50
Chloride of sodium ...	26
Sulphate of soda...	6
" magnesia ...	3
Insolubles ...	15
	100

but a more average sample might be taken to contain one-third nitrate; one-third salt; and one-third earth.

The problem for the manufacturer is to get the nitrate without the salt and earth; and the simple basis of the whole process rests on the fact that, while salt is rather more soluble in cold

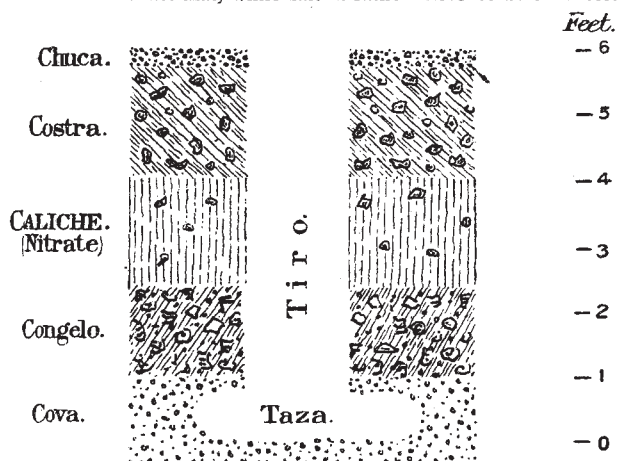


FIG. 3.

than in hot water, nitrate of soda is about four times more soluble in hot than cold water. It is also evident that, if a salty rock is washed with water already saturated with salt, no more of that material can be absorbed. The raw *caliche* is therefore first crushed into small pieces, washed with six changes of hot water, by what is known as the "passing system" similar to that used for lixiviating soda ash. After the last washing the waste *caliche* is known as *ripio* (refuse), and is thrown on to a rubbish heap; while the strongest hot water, which is drawn off the *caliche*, is known as *caldo*, or "broth."

The hot broth then runs for twenty minutes into a settling tank, where earth and salt are deposited, and after that into great square shallow *bateas*, or troughs. In about five days the greater part of the nitrate has been deposited nearly pure at the bottom of the *batea*, and a yellow orange liquid, known as *agua vieja*, remains on the top. This liquid is drawn off, the nitrate crystals drained, thrown on to a flat floor or *cancha*, to dry for three weeks, and then when bagged are ready for the market.

In many factories the *agua vieja* is then pumped into the iodine room.

One sample of this fluid gave the following analysis:—

	Per cent.
Nitrate of soda...	28
Sulphate " ...	3
Chloride of sodium ...	11
Iodate " ...	22
Sulphate of magnesia ...	3
Water ...	33
	100

besides a small quantity of iodide of sodium, which cannot be utilized.

To separate the iodine a mixture of nitrate of soda and coal dust is formed into a pyramid and set alight, by which means a crude carbonate of soda is formed. Fumes of burning sulphur are then drawn through a solution of this carbonate, and an acid solution of sulphite of soda is produced. A suitable quantity of this last liquid is added to the *agua vieja*, when iodine is precipitated in an impure form, which after sublimation becomes the iodine of commerce.

Nitrate of soda thus manufactured contains from 95 to 96 per cent. of pure nitrate, with less than $1\frac{1}{2}$ per cent. of salt, the remainder being chiefly water. The nitrate is sold in Liverpool for about 10s. a hundredweight, while the iodine is disposed of in London for about 3d. an ounce.

It is impossible to examine a bed of crude nitrate of soda, without thinking how it got there. We have described the facts as to the position of some beds relative to the lie of the country, and also explained the character of the layers which adjoin the *caliche*, but unfortunately we can do little more. Numerous theories have of course been started, but none have either accounted for all the facts, or obtained general acceptance. This may perhaps be the case because no competent geologist has as yet thoroughly examined the nitrate beds in different parts of the country, but still a few remarks on the subject may be desirable. There is no doubt that the coast range and the Pampa have been elevated out of the sea at a comparatively recent period, but it is also equally certain that since that elevation the climate was at one time far more rainy than at present. All over the plains there are dry river-beds, and the flanks of the hills are scored by water-cut channels which could not have been carved out under the existing conditions of rainfall. This would make it doubtful whether the nitrate could have been deposited immediately after upheaval.

It may be noted as a curious fact that the stones found both in the *costra*, *caliche*, and *congeló* are usually angular; but in one nitrate ground I have certainly seen rounded pebbles in all these formations.

Much difficulty is always found in accounting for the existence of nitric acid. The existence in some deposits of a layer of guano under the *caliche* is a very suggestive fact, but unfortunately our knowledge of the circumstances is far too limited to allow of any generalizations on the subject. The presence of iodine in *caliche* has often been appealed to as pointing to the decomposition of beds of seaweed; but it may be remarked that there is a good deal of iodine about in the neighbouring mountains in the form of iodide of silver. We can only repeat the statement that the origin of nitrate of soda is at present unknown.

Whatever may have been the origin of the beds, there is no doubt that their existence is due to the rainlessness of the west coast of South America, so that a few remarks on the climate and weather of the *caliche* districts may be of interest. All along the coast we find three belts of climate and weather: that of the coast, that of the Pampa, and that of the Sierra.

Iquique may be taken as a typical station on the coast, and here fortunately a considerable amount of material has been accumulated through the labours of the Meteorological Commission for Chili. Speaking broadly, temperature at any season will rarely exceed 80° – 85° , or fall below 50° at any hour in the coldest season; and as the air is always tolerably dry the climate is very bearable and wholesome. The wind blows from south to south-west throughout the year during the day, but at night sometimes comes more off the land from some point of east. Though nothing approaching to a gale ever blows at Iquique, the effect of distant storms is often experienced in the form of a heavy surf, which entirely stops any shipment of nitrate. The surf days, or *Bravesas* as they are called, occur most irregularly, for while in some years only nine days are recorded, other seasons have been credited with no less than forty-three days of enforced idleness. Contrary to the usual opinion, three or four slight but real showers fall every year, mostly in the months of June, July, and August, though this precipitation does not extend inland to the Pampa. The sky is usually clear, but a low stratus or strato-cumulus cloud often covers the sea and coast range during the forenoon, but dissipates as the sun gains power.

On the Pampa, where all the nitrate *oficinas* are built, the temperature may rise to 85° or 90° on the hottest days; and at night may fall to the freezing-point during the winter months. The air is much drier than on the coast; and though rain has been known to fall, it is certainly of very rare occurrence. Cloud is more rare on the Pampa than on the coast; but nearly every night a very thick wet fog settles over the plain. This is locally known as *camanchaca*, probably an Aymara word, whose

signification I have not been able to find out. The mist is popularly supposed to come from the sea, but this is only partly true. The fog doubtless rolls from the west or seaward side, but the origin is certainly due to local radiation, for the densest mist may lie over the Pampa, when there is no trace of fog on the sea-coast.

The nights and forenoons are usually calm on the Pampa, but about 1 p.m. a moderate wind springs up from the south-west, which falls away at sunset. During the night a light air sometimes blows from the Cordillera; and if the wind comes from the east, the *camanchaca* is immediately evaporated.

The Sierra or Cordillera is strangely enough governed by a totally different weather system from that of the coast; for it rains heavily in the mountains during the summer months of December, January, or February; and I have been assured that whenever it does rain on the Pampa, the precipitation has been blown over from the Sierra. *The extreme dryness of the Pampa is owing to its geographical position between the coast range, whose scanty rainfall occurs in winter, and the Sierra, where heavy rain falls in summer, but the precipitation of neither reaches the plain, which therefore remains a desert.* My own observations on the surface and upper winds along the whole length of the Andes, from Valparaíso to Lima, prove conclusively that the old theory that the dryness of the west coast of South America is due to the south-east trade rising over the Andes, and then descending as a warm dry current, is totally wrong, for I found all the winds over 10,000 feet, either from north-east or north-west.

The Pampa is very healthy, for fever is unknown, and though the heat and drought sometimes affect the liver, and a mild dysentery sometimes shows itself, still both are very amenable to proper treatment. There seems to be only one ailment special to the Pampa and the other nearly rainless districts of South America. This is the so-called "barley blindness" of mules and horses, which manifests itself by a white growth on the pupil of the eye. Absence of sufficient moist food is said to be the cause of this malady, and there is no doubt that if removed in time to a natural pasturage, the affected animal soon more or less recovers its sight.

RALPH ABERCROMBY.

FORTUITOUS VARIATION.

AT a meeting of the Biological Society of Washington (United States), held on December 15, 1888, Mr. Lester F. Ward read a paper on "Fortuitous Variation, as illustrated by the genus *Eupatorium*." He exhibited a series of specimens of that genus, mostly from the vicinity of Washington, and growing in great part in the same kind of soil and under the same general conditions. To simplify the question, the differences in the flowers, heads, and reproductive parts in general, which are less marked in this than in almost any other genus, were ignored, and attention was exclusively directed to the leaves. These, when closely compared, are seen to differ considerably in the different species, the forms ranging from the filiform dissected leaves of *E. feniculaceum* to the broad ovate leaves of *E. ageratoides*. But between these extremes there are represented in the Washington flora numerous much more similar forms, which present to the observer a strongly marked family resemblance; from those with more elongate leaves, such as *E. altissimum*, *E. album*, and *E. teucrifolium*, through the increasingly broader more ovate forms, *E. perfoliatum*, *E. sessilifolium*, and *E. rotundifolium ovatum* (*E. pubescens*, Muhl.), with an intermediate undescribed form, which Dr. Gray regarded as a hybrid, connecting the last two to the typical *E. rotundifolium*, with its roundish, crenate, but still sessile leaves; and from this last form, with several similar Mexican species, on in the direction of acquiring a petiole, through several exotic forms, to *E. exaltatum*, *E. aromaticum*, and *E. ageratoides*, in an almost unbroken chain of modifications without any apparent advantage to the plants. Almost any other genus might have served the purpose of the paper, but this one seemed to possess the merit of simplicity.

The question naturally arises, in looking at such a group of clearly related forms, all of which, on the modern view, must surely have descended from some common ancestral stock, Why have they varied at all? Why need there be more than one species of *Eupatorium* in the same restricted flora? Or, if some can be shown to have probably varied in order to adapt themselves to different local conditions, why need there be more than one form occurring under precisely the same conditions? Variation caused by natural selection can only occur where some advantage is secured through it, whereby the new form becomes,

by ever so little, better fitted to survive under the conditions of its existence. But here there seems to be no such advantage. It is easy to say that we are incapable of detecting the subtle influences that make one form surer of existence than another. The staunch believer in natural selection may be satisfied with such an explanation, but is it not too much to ask of the new convert or the sceptic? Is not the spread of the doctrine hindered rather than helped by such a demand? Moreover, it was shown that several different forms actually flourish together in the very same localities, and that this is not exceptional, but the common case, so that the idea of special fitness of form to station is precluded. And is it not antecedently improbable that there should be any advantage in a plant's having a sharp-pointed rather than a blunt-pointed leaf, a serrate rather than a crenate one, or a sessile rather than a short-petioled one? Science becomes metaphysics when such questions are discussed.

The speaker proposed to escape from the dilemma by denying that advantage, or fitness to survive, or natural selection, had anything to do with such variations; and he maintained that they were truly fortuitous in the only true sense of that term. By this he did not mean to say that they were due to mere chance in the sense of being without cause; and the remainder of his paper was devoted to an attempt to explain the cause of fortuitous variation. It may be briefly summed up as follows:—

Organized or living matter constantly tends to increase in quantity, which may be regarded as the true end of organic being, to which the perfection of structure, commonly mistaken for such end, is only one of the means. Every organic element may be contemplated as occupying the centre of a sphere, toward the periphery of which, in all directions alike, it seeks to expand, and would expand but for physical obstructions which present themselves. The forms which have succeeded in surviving are those, and only those, that were possible under existing conditions; that is, they have been developed along the lines of least resistance, pressure along all other lines having resulted in failure. Now, the various forms of vegetable and animal life represent the latest expression of this law, the many possible, and the only possible, results of this universal *nisus* of organic being. The different forms of *Eupatorium*, or of any other plant or animal, that are found co-existing under identical conditions merely show that there were many lines along which the resistance was not sufficient to prevent development. They are the successes of Nature.

Mr. Ward disclaimed any desire to discredit or impair in any way the great law of natural selection. The most important variations, those which lead up to higher types of structure, are the result of that law, which therefore really explains organic evolution; but the comprehension and acceptance of both natural selection and evolution are retarded instead of being advanced by claiming for the former more than it can explain, and it might as well be recognized first as last that a great part—numerically, by far the greater part—of the variety and multiplicity, as well as the interest and charm, of Nature is due to another and quite distinct law, which, with the above qualifications, may perhaps be appropriately called "the law of fortuitous variation."

SCIENTIFIC SERIALS.

American Journal of Science, July.—A new Erian (Devonian) plant allied to Cordaites, by Sir William Dawson. This unique specimen from the lower Catskill (Upper Devonian), Wyoming County, Pennsylvania, presents the peculiarity of combining the fructification of the Cordaites with foliage akin to that of *Næggerathia*, thus connecting two Palæozoic groups which are now considered as allied to Cyadeæ and Taxineæ.—The law of thermal relation, by William Ferrel. The object of these researches is to compare Dulong and Petit's older formulæ and the more recent determination of Stefan with the principal available data derived from experiment and observation, with a view to ascertaining what modifications these formulæ may require in order accurately to represent the true law of relation between the intensity of the radiation and the temperature of a body. It appears generally that neither of the formulæ in question represents the true law of Nature through the whole range of experiments, but that different values are required for different ranges of temperature. To determine the true mean value with greater accuracy experiments upon radiation will have to be made at much lower temperatures than any yet made.—Stratigraphic position of the Olenellus fauna in North America and Europe (continued), by Charles D. Walcott. Since writing the first part